Clear Lake Watershed Monitoring and Modeling Plan
Water Years 2011-2013

Suggestions by USGS and UC Davis

for discussion by the
Blue Ribbon Committee for the Rehabilitation of Clear Lake
Technical Subcommittee

March 26, 2020

USGS
science for a changing world

UCDAVIS

2019 Recommendations
by Blue Ribbon Committee

- Watershed Modeling
  - Joint proposal by USGS and UC Davis
- Watershed Monitoring
  - Details to be worked out by Technical Subcommittee
- Bathymetry of Clear Lake
- Socioeconomics
- Community Survey

Watershed Modeling: A multi-model approach

- LSPC / HSPF
    - Climate analysis includes Climate Change Scenarios
        - 4 General Circulation Models, as in California Climate Assessment
    - Compute loads of N, P, sediment, and mercury
    - Necessary input (monthly, daily) for SPARROW and Clear Lake models
- SPARROW
    - GIS approach to determining nutrients (N,P) and sediment loads as a function of land use and watershed characteristics
    - Uses gaged streams for calibration, using calculated loads
    - Dynamic version has monthly time step
    - Decision support system to evaluate management scenarios
- Sediment Fingerprinting
    - Sampling of soils, streambed sediments, and streambank deposits
        - Chemical and isotopic analyses (~ 65 constituents)
    - Independent determination of N and P sediment sources
        - Land use categories
        - Geologic units / soil types

LSPC / HSPF Modeling

- Loading Simulation Program in C ++ (LSPC)

- Hydrological Simulation Program FORTRAN (HSPF)
  - Comprehensive semi-distributed watershed models
  - Describe runoff, sediment transport & nutrient transport

- Require continuous time series data as input
  - Air temperature
  - Precipitation
  - Potential evapotranspiration (PET)
  - Climate Change Scenarios will be evaluated

- Previous HSPF models for Cache Creek watershed will be expanded and recalibrated
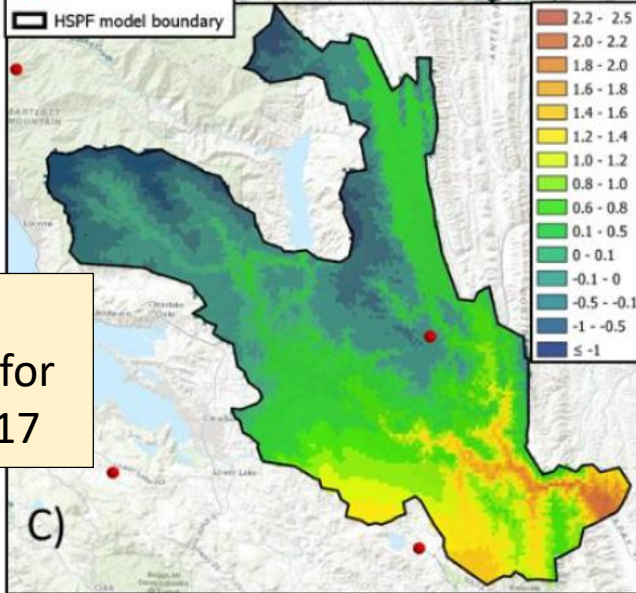
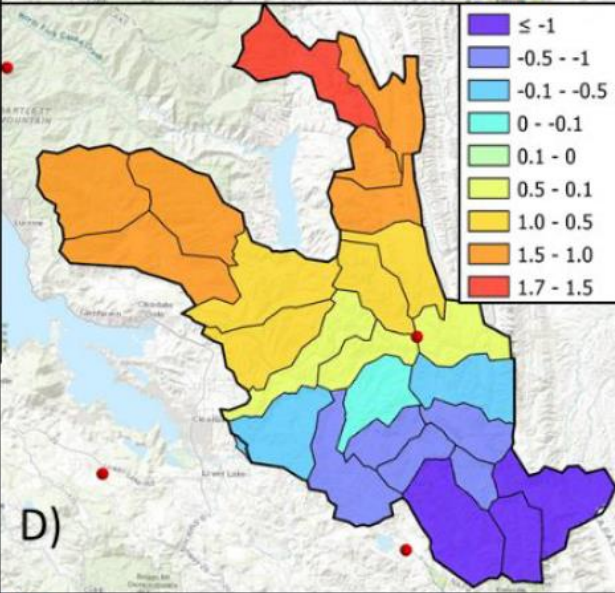# Development of Climate Grids

Minimum Air Temp, Jan. 7, 2017
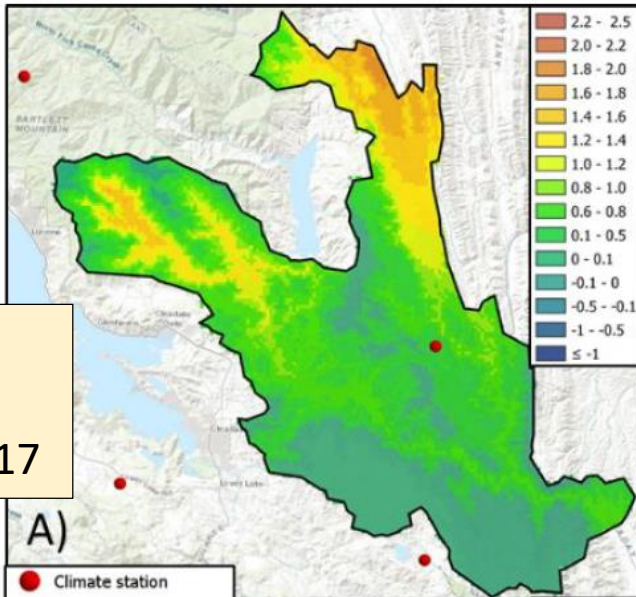
Monthly rainfall (PRISM) for Jan., 2017
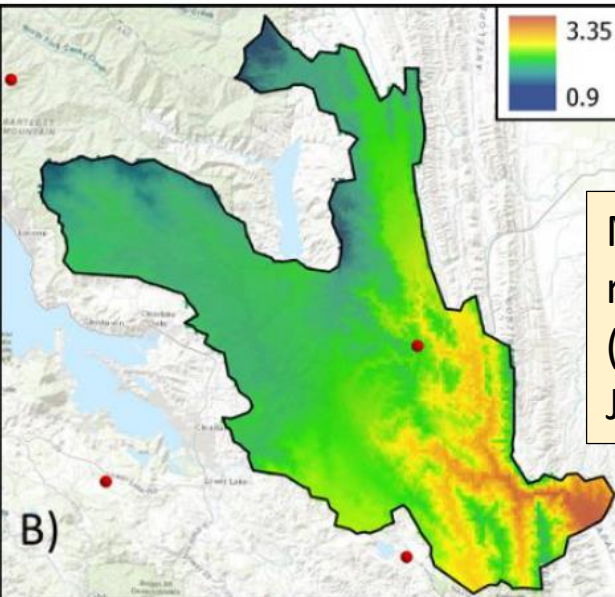
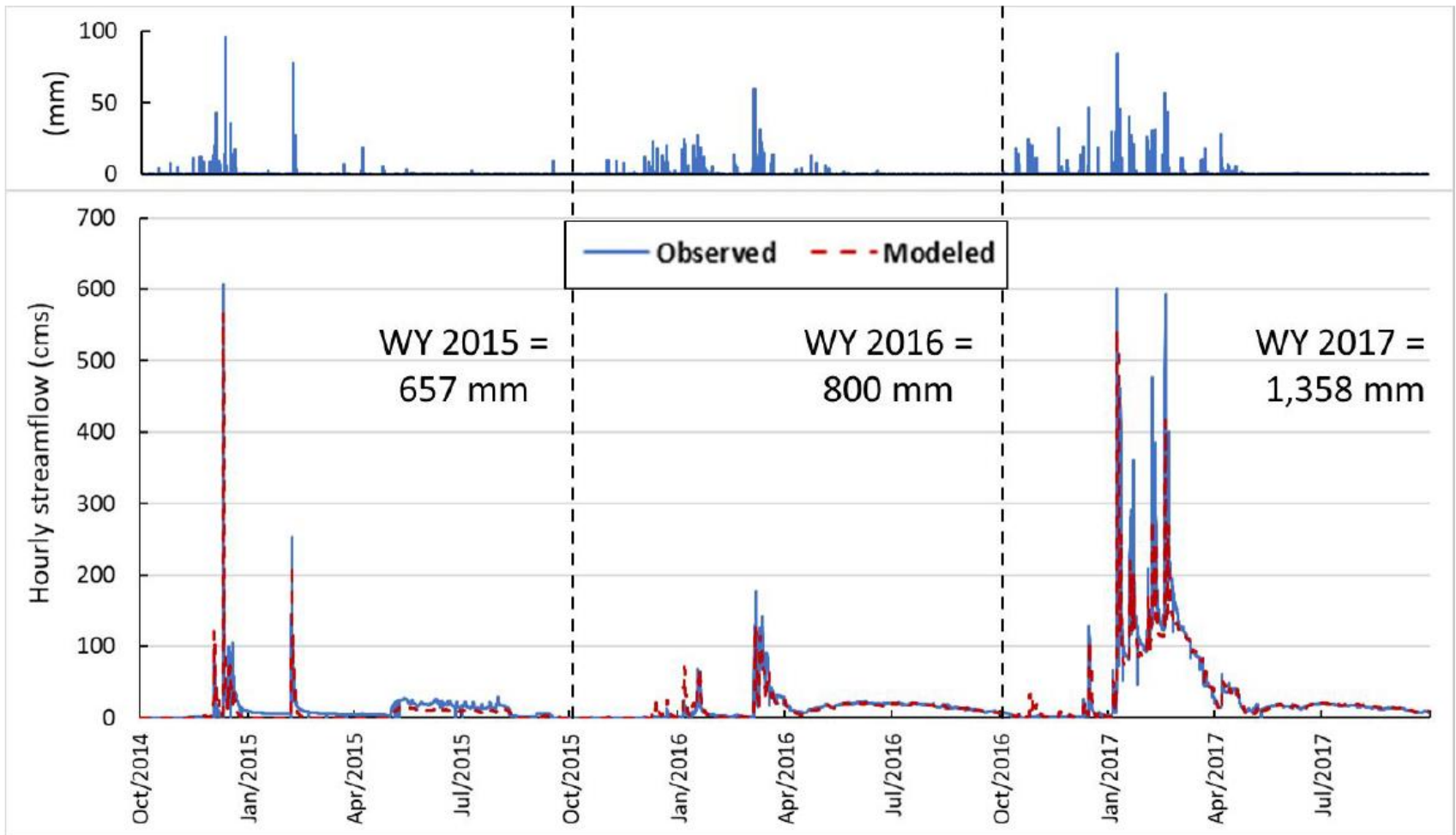Adjusted daily grid for Jan. 7, 2017

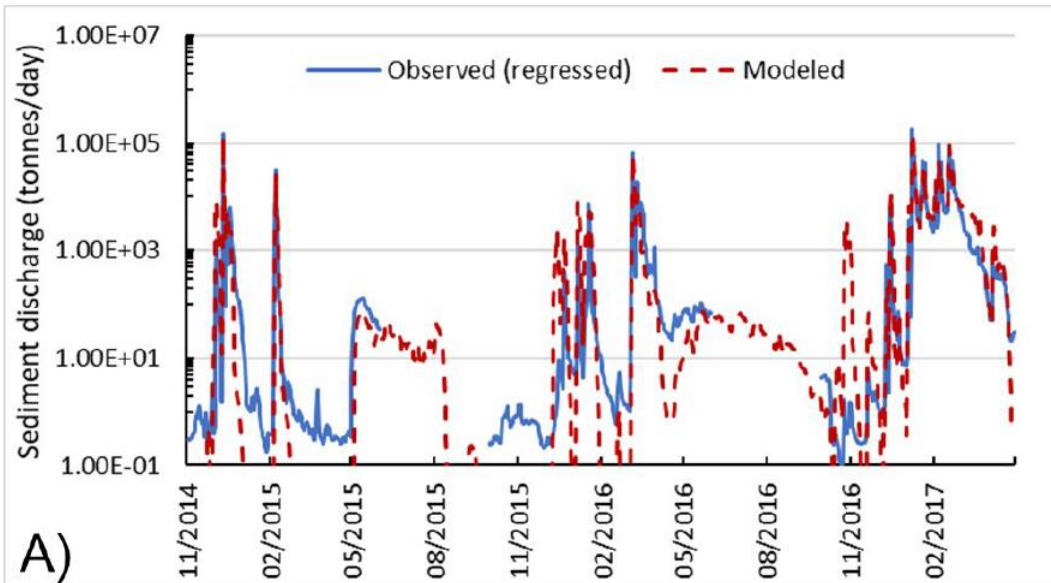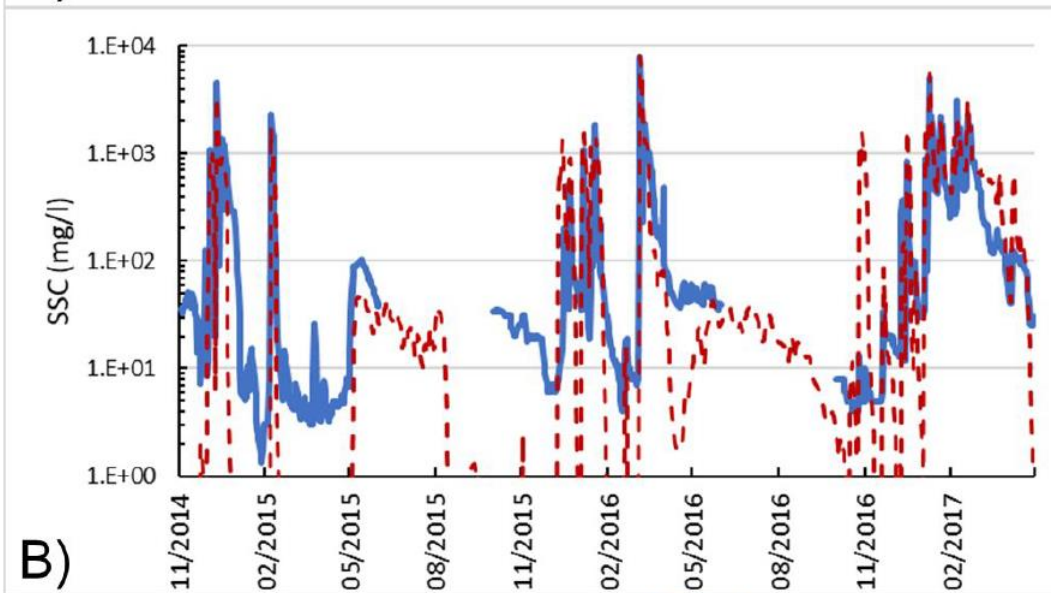Differences in daily grid by sub-basin for Jan. 7, 2017

Stern et al. (in review)

Runoff simulation with HSPF

Cache Creek at Rumsey

Stern et al. (in review)

Sediment simulation with HSPF
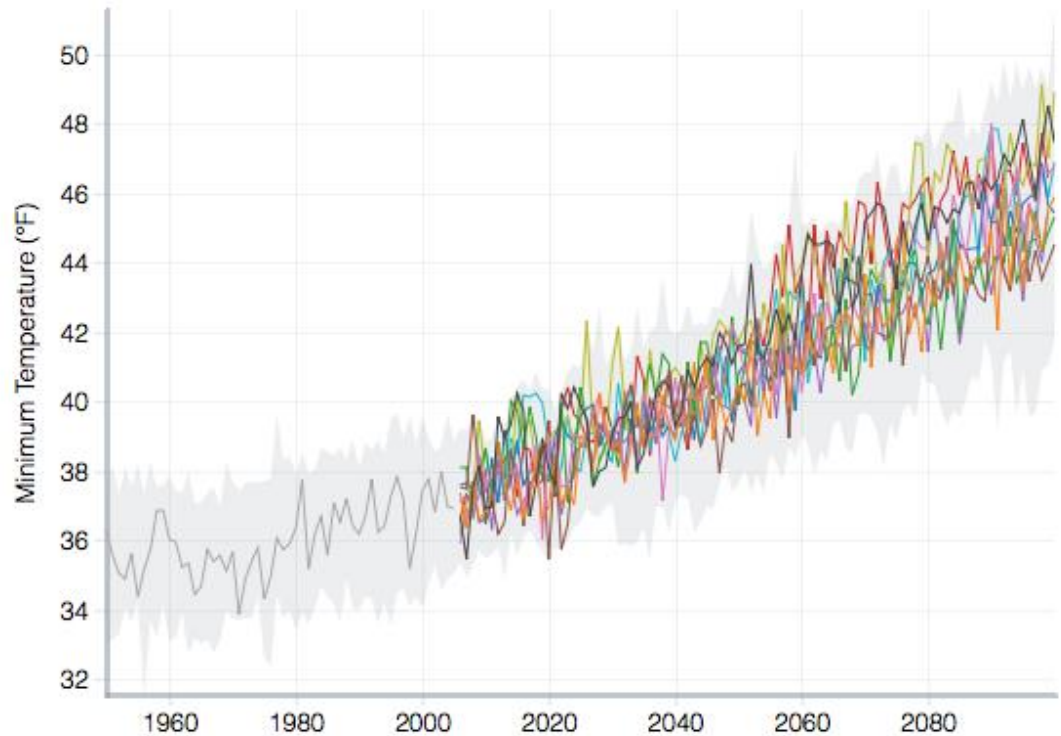

Cache Creek at Rumsey

Stern et al. (in review)

Temperature Projected to Rise Substantially

under plausible future greenhouse gas emissions

BY 2100
AVERAGE ANNUAL TEMPERATURES
ARE PROJECTED TO
INCREASE BY
6 – 9º F

# Results from Lake Tahoe climate projections
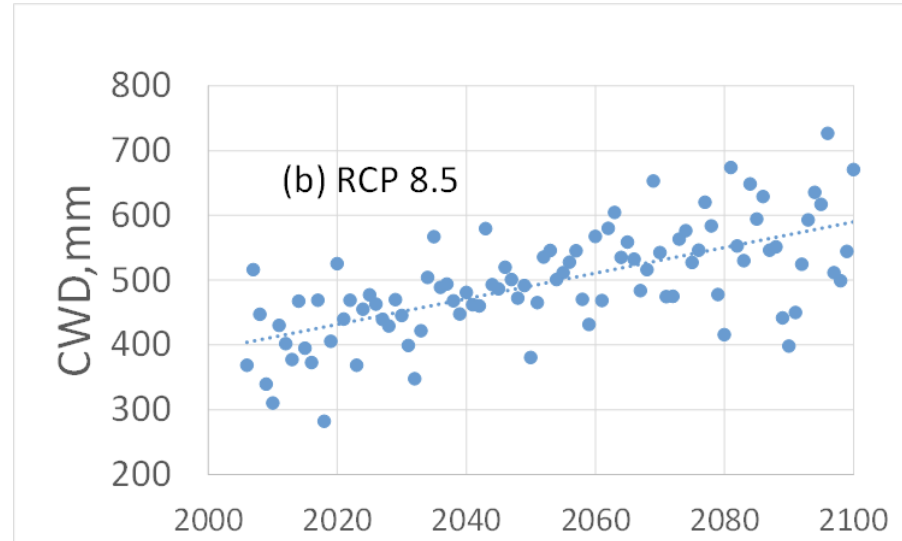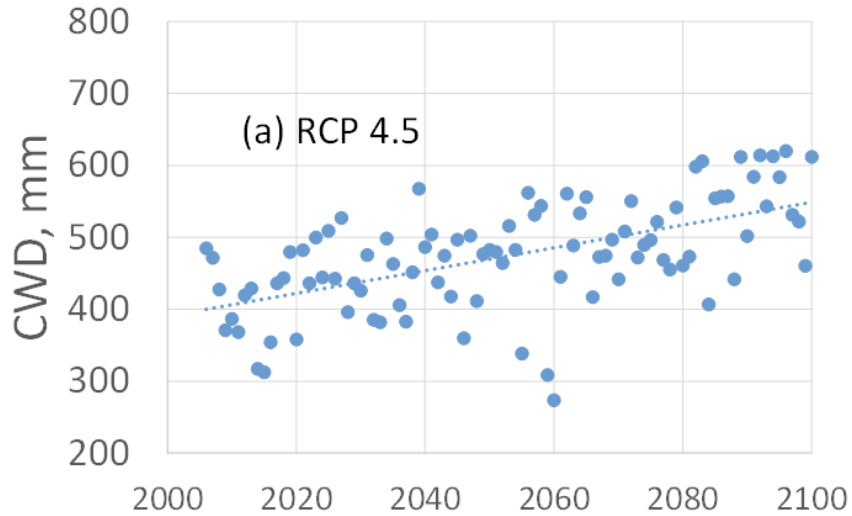
Two future emission scenarios show large and significant increases in the Climatic Water Deficit, exceeding 120 percent increases in some parts of the basin by the end of the century.

This impacts runoff, erosion, and fire hazard.

SPARROW modeling

- <u>SPA</u>tially <u>R</u>eferenced <u>R</u>egression <u>O</u>n <u>W</u>atershed attributes
- Statewide models for California based on 2002 and 2012 base years but with no calibration sites in Clear Lake watershed
- Dynamic model (seasonal) applied to Upper Klamath Basin
- Calibration of Dynamic SPARROW model for Clear Lake watershed will require additional monitoring
  - Propose 4 new stream gages (7 total)
  - Nutrient loads (total N and P) at each gaging station
  - Dissolved forms of N and P not needed directly for model, but help inform differences between individual catchments
- Decision Support Tool for Clear Lake will be developed
  - Public workshops planned to get input on design

SPARROW – conceptual framework
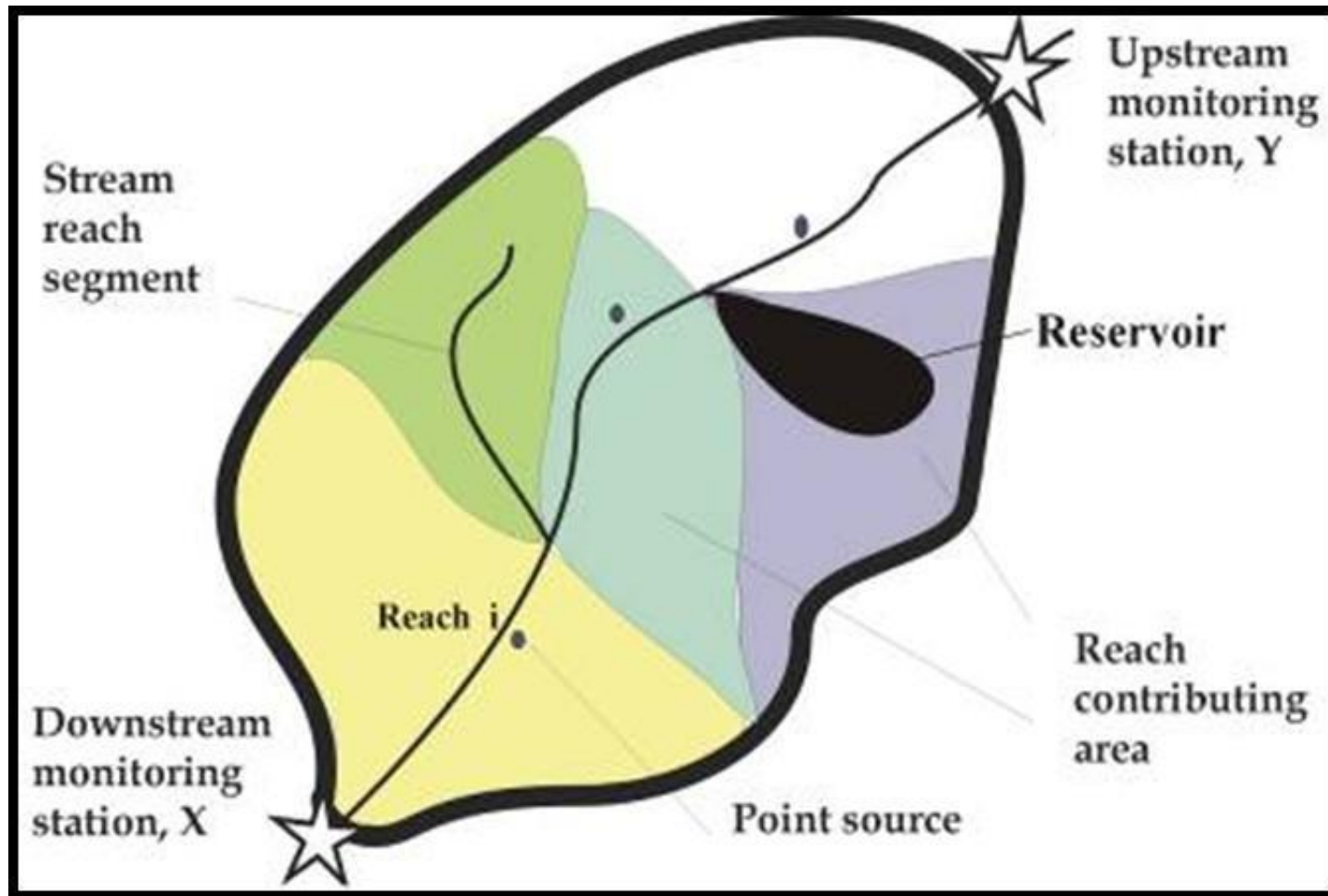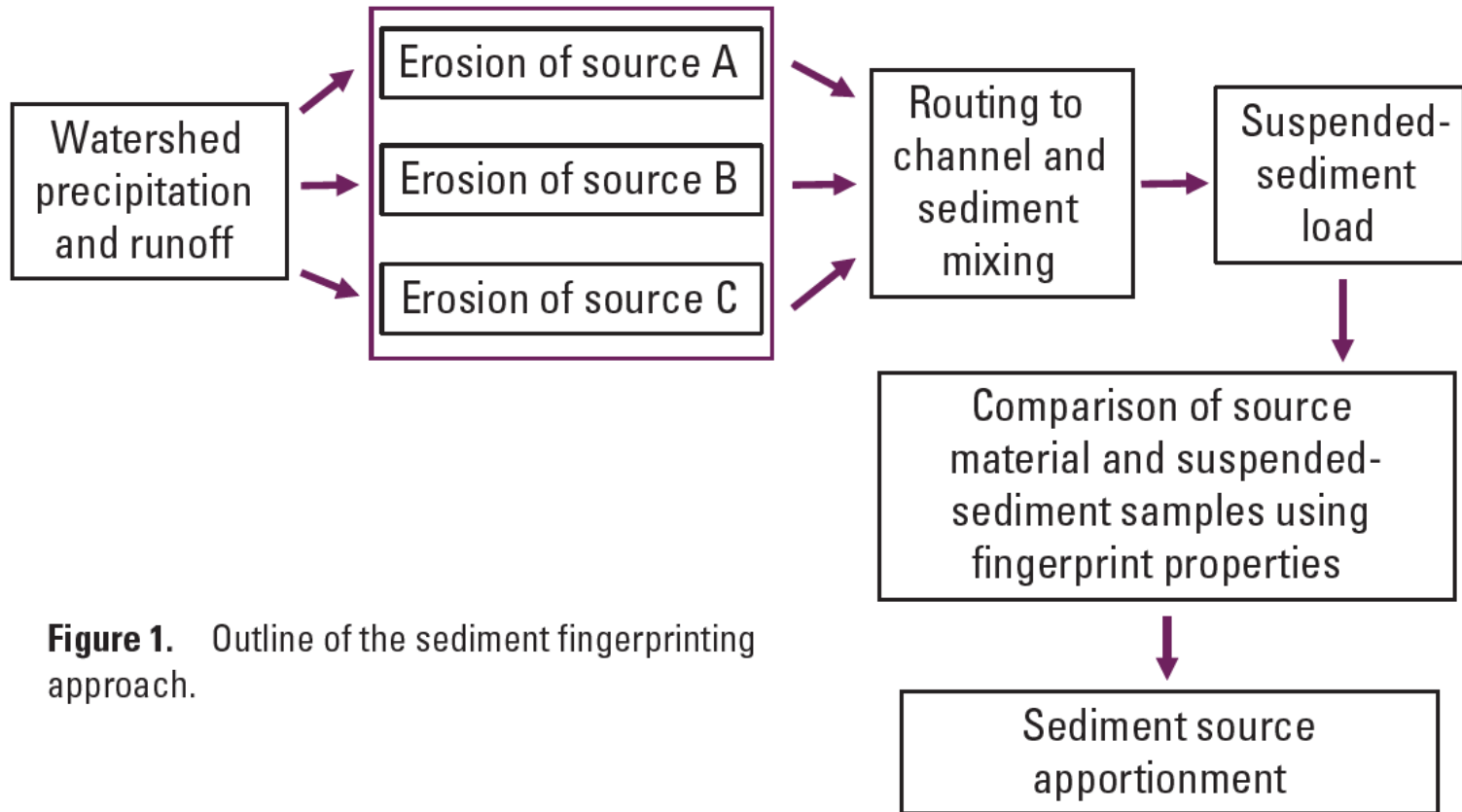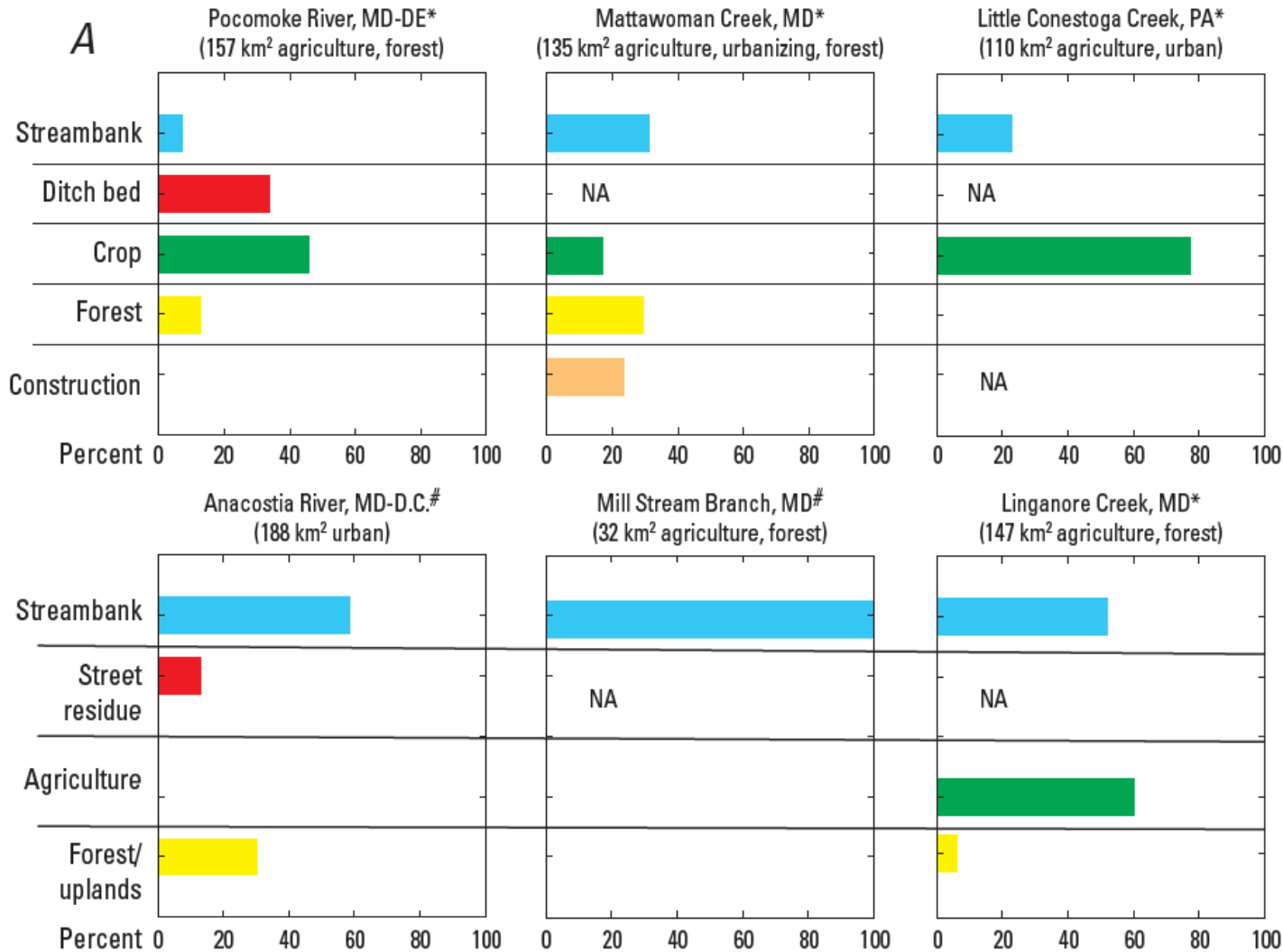
Sediment Fingerprinting

Figure 1. Outline of the sediment fingerprinting approach.

Sediment Fingerprinting

Small watershed studies in Chesapeake Bay, Maryland

Sediment Fingerprinting – proposed approach for Clear Lake

Land Use	Number of Samples				
	Streambed sediment	Stream bank	Soil - A Horizon	Soil - B Horizon	Total
Forest - minimal logging or ORV use	12	12	12	12	48
Forest - logging	12	12	12	12	48
Forest - Heavy Off-Road Vehicle use	12	12	12	12	48
Rangeland - cattle grazing	12	12	12	12	48
Agriculture - row crops	12	12	12	12	48
Agriculture - other	12	12	12	12	48
Urban / Suburban	12	12	12	12	48
Total	84	84	84	84	336

Samples by Sub-watershed	Number of Samples					
	Streambed sediment	Stream bank	Soil - A Horizon	Soil - B Horizon	Suspended Sediment	Totals
Adobe Creek	12	12	12	12	3	51
Burns Valley	6	6	6	6	3	27
Clover Creek	6	6	6	6	3	27
Cole Creek	12	12	12	12	3	51
Kelsey Creek	12	12	12	12	3	51
Manning Creek	6	6	6	6	3	27
Middle Creek	12	12	12	12	3	51
Schindler Creek	6	6	6	6	3	27
Scotts Creek	12	12	12	12	3	51
Total	84	84	84	84	27	363

Sediment Fingerprinting – proposed approach for Clear Lake

Planned analyses
Total N
Total P
Total C
Total Inorganic C
Major elements & Trace elements (ICP)
Total Hg
$\delta15N$
$\delta13C$
$\delta18O$ in PO_4
137-Cs, 210-Pb, 7-Be
Pb stable isotopes
Hg isotopes
Sr isotopes
Grain-size distribution

Also could add: Quantitative mineralogy by X-ray diffraction (QXRD)

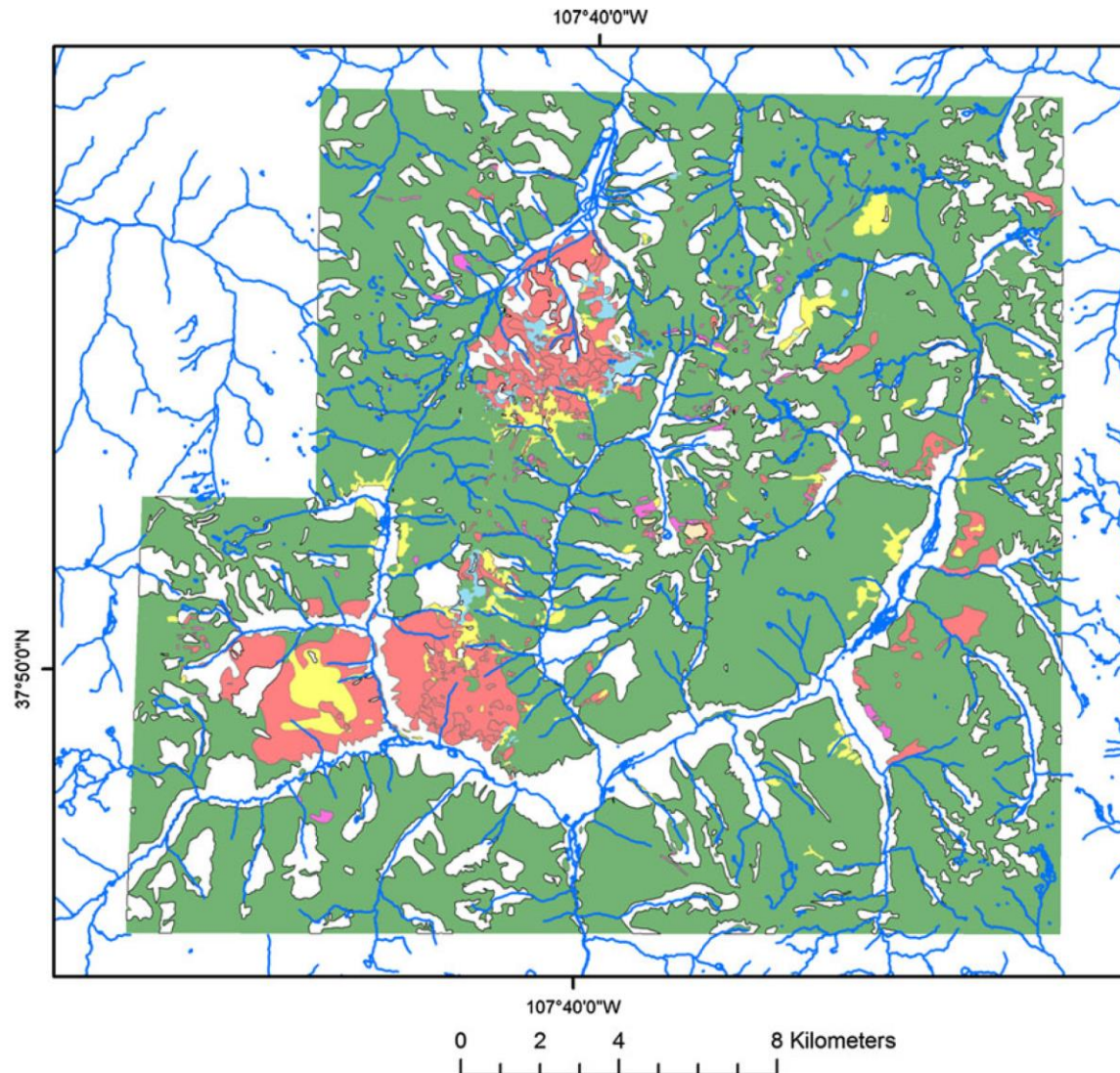# Remote sensing data -- ASTER

Animas River watershed, Silverton, CO
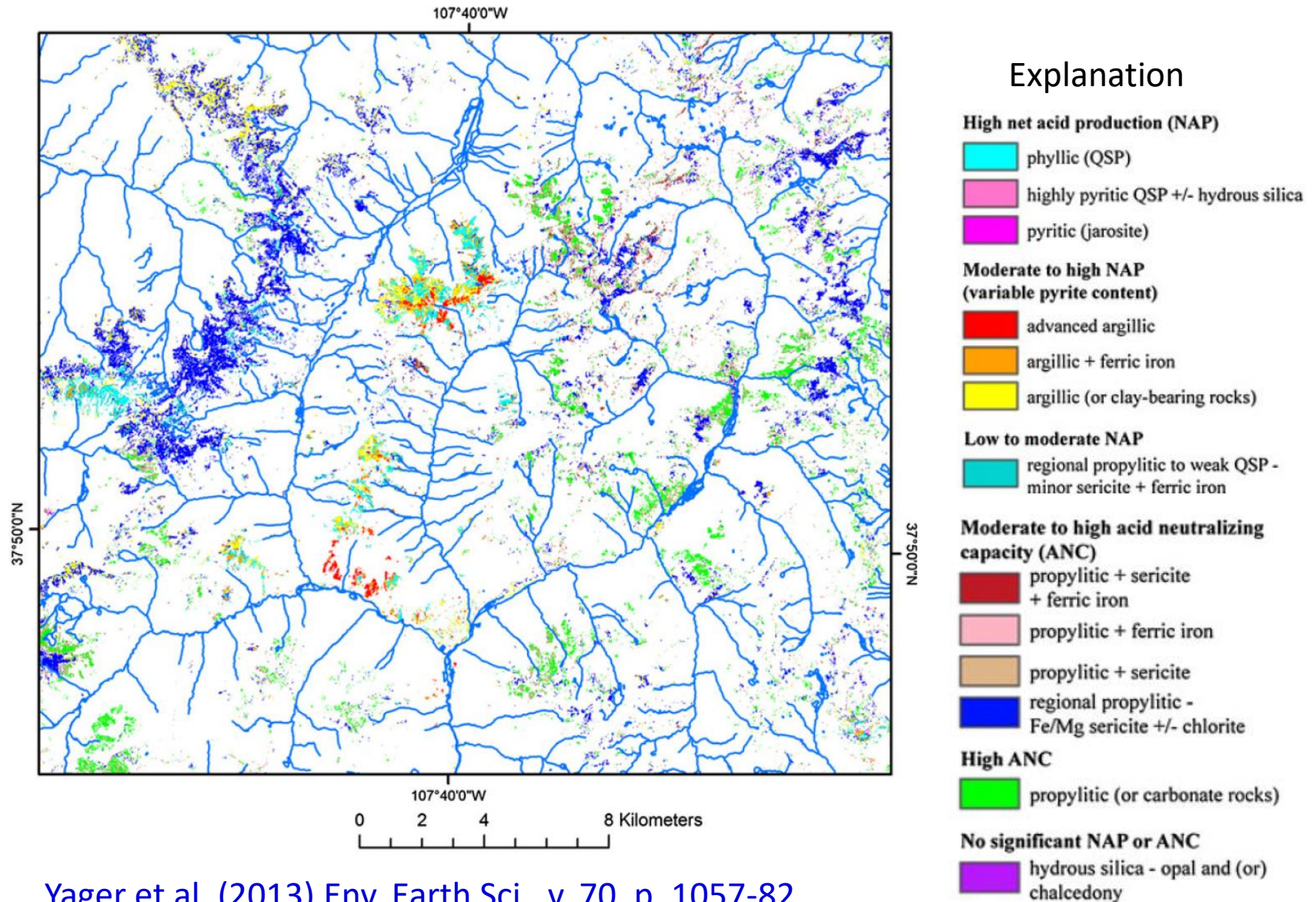
Yager et al. (2013) Env. Earth Sci., v. 70, p. 1057-82

Remote sensing data -- AVIRIS

Animas River watershed, Silverton, CO

Map based on analysis of AVIRIS data with ground-truthing

Green –Propylitic alteration (chlorite, calcite)

Red – Advanced Argillic alteration (alunite, kaolinite)

Yellow – Quartz-Sericite-Pyrite alteration (quartz, mica)

Yager et al. (2013) Env. Earth Sci., v. 70, p. 1057-82

Remote sensing data -- LANDSAT Thematic Mapper

Rockwell (2013) USGS SIM 3252
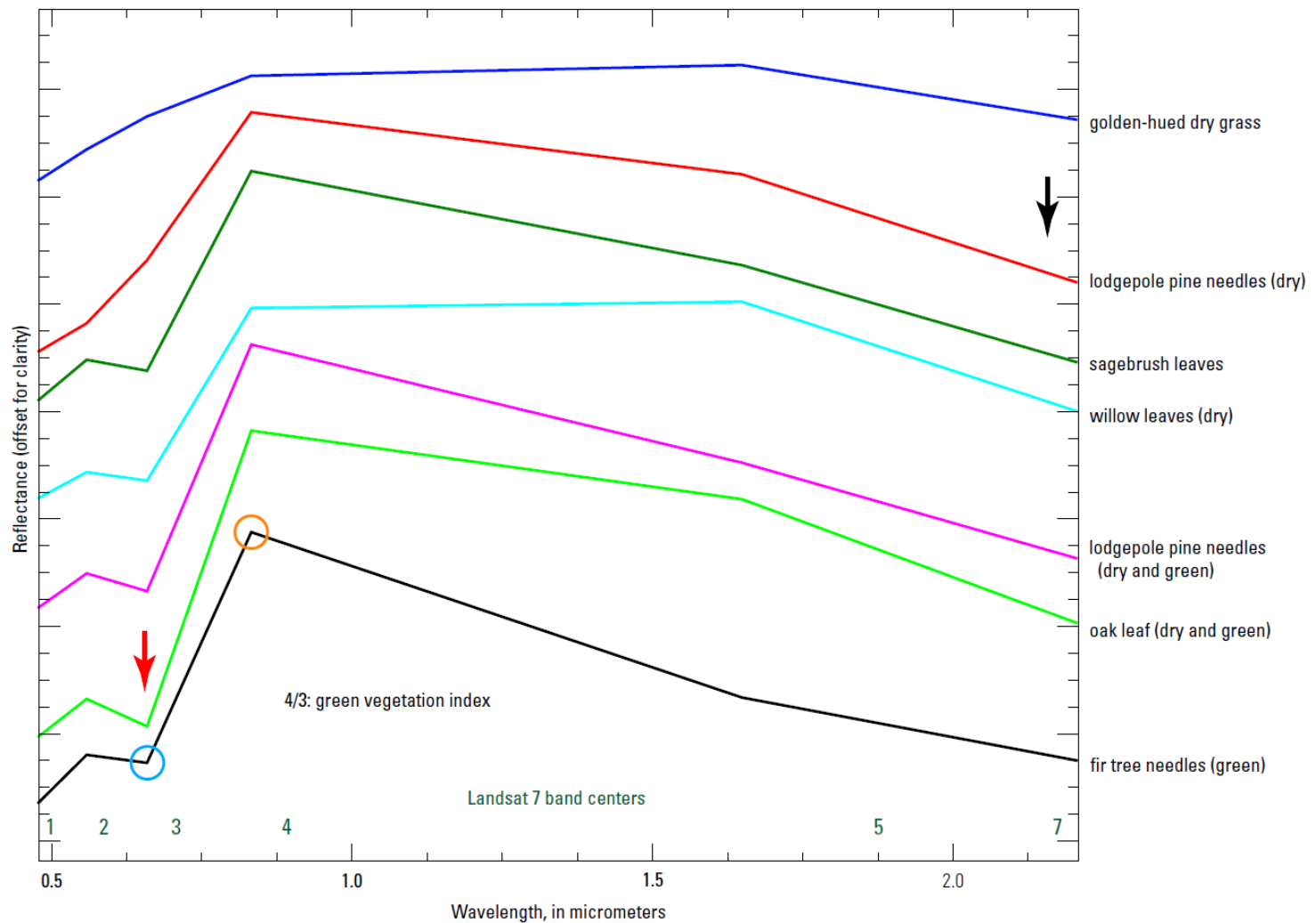
Proposed Schedules of Monitoring Parameters

Stream Sites

Schedule C (current practice)	Schedule B (add filtered nutrients)	Scheudule A (add mercury species)
Total nitrogen in unfiltered water (TN)	Dissolved Organic Carbon (DOC)	Total mercury in filtered water
Amonia plus organic nitrogen in unfiltered water (Kjeldahl) (TKN)	Particulate Carbon (PC)	Particulate total mercury
Nitrate plus nitrite in unfiltered water (TNO3+NO2)	Ammonia and ammonium in filtered water	Methylmercury in filtered water
Total phosphorus in unfiltered water (TP)	Ammonia plus organic nitrogen in filtered water (Kjeldahl) (DKN)	Particulate methylmercury
EEMS on DOM (excitation emission matrix spectra) -- includes SUVA254	Nitrite plus nitrate in filtered water	EEMS on DOM (excitation emission matrix spectra) -- includes SUVA254
CAMS -17 in unfiltered water	Total nitrogen in filtered water (TDN)	Trace metals in filtered water (ICP, 50 elements)
Fe, Al, and Mn in unfiltered water	Particulate Nitrogen (PN)	
Si in filtered water	Orthophosphate in filtered water (SRP)	
Total organic carbon (TOC) - unfiltered water	Total phosphorus in filtered water (TDP)	
	Particulate phosphorus	
	Particulate size distribution (laser scattering)	

Plus parameters in Schedule C

Plus parameters in Schedules B and C

Clear Lake Sites

Schedule D
Chlorophyll-a
Cyanotoxins